

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A polishing head for positioning a surface of a substrate against a polishing surface, the polishing head comprising:

a carrier;

a subcarrier carried by the carrier and adapted to hold the substrate during a polishing operation;

and

a retaining ring having an inner edge disposed about the subcarrier and a lower surface in contact with the polishing surface during the polishing operation, the lower surface of the retaining ring having at least one annular recess, the at least one annular recess positioned a predetermined distance from the inner edge of the retaining ring, the predetermined distance selected based on magnitude of a force applied to the retaining ring during the polishing operation, magnitude of a force applied to the subcarrier during the polishing operation, or both. ~~formed therein to inhibit non-planar polishing of the surface of the substrate.~~

2. (Currently Amended) A polishing head according to claim 1, wherein the polishing surface comprises a pad of pliant material capable of being deformed by the retaining ring during thea polishing operation.

3. (Currently Amended) A polishing head according to claim 2, wherein the at least one annular recess is adapted to reduce a length of time during which the polishing surfacepad is deformed by the retaining as the retaining ring is moved relative to the polishing padsurface.

4. (Cancelled)

5. (Currently Amended) A polishing head according to claim 1[4], wherein the at least one annular recess is positioned a predetermined distance from the inner edge of the retaining ring, the predetermined distance selected to reduce the area near the edge of the substrate having a lower polishing rate than a center of the substrate due to rebounding of the pad.

6. (Cancelled)

7. (Currently Amended) A polishing head according to claim 15, wherein the predetermined distance is selected based on a hardness of the padpolishing surface.

8. (Currently Amended) A polishing head according to claim 9[4], wherein the ~~at least one annular recess has a predetermined depth and~~ the a predetermined radial width are in the lower surface of the retaining ring selected to reduce the area near the edge of the substrate having a lower polishing rate than a center of the substrate due to rebounding of the polishing surfacepad.

9. (Currently Amended) ~~A polishing head according to claim 8,~~ A polishing head for positioning a surface of a substrate against a polishing surface, the polishing head comprising:

a carrier;

a subcarrier carried by the carrier and adapted to hold the substrate during a polishing operation;

and

a retaining ring having an inner edge disposed about the subcarrier and a lower surface in contact with the polishing surface during the polishing operation, the lower surface of the retaining ring having at least one annular recess, the annular recess having a predetermined depth and a predetermined radial width, wherein the predetermined depth and the predetermined radial width are selected based on magnitude of a force applied to the retaining ring during the polishing operation, magnitude of a force applied to the subcarrier during the polishing operation, or both.

10. (Currently Amended) A polishing head according to claim 9, wherein the predetermined depth and the predetermined radial width are selected based on a hardness of the polishing surface.

11. (Currently Amended) A polishing head for positioning a surface of a substrate against a polishing surface, the polishing head comprising:

a carrier;

a subcarrier carried by the carrier and adapted to hold the substrate during a polishing operation;

and

a retaining ring having an inner edge disposed about the subcarrier and a lower surface in contact with the polishing surface during the polishing operation, the lower surface of the retaining ring having at least one annular recess according to claim 1, wherein the at least one annular recess comprises a groove having a curved cross-sectional area in a plane perpendicular to the lower surface of the retaining ring.

12. (Original) A polishing head according to claim 11, wherein the groove comprises a hemispherical cross-sectional area.

13. (Original) A polishing head according to claim 1, wherein the at least one annular recess comprises a plurality of concentric grooves.

14. (Currently Amended) A Chemical Mechanical Polishing (CMP) apparatus having a polishing head ~~with a polishing head according to claim 1,~~ the CMP apparatus further comprising:

a chemical dispensing mechanism adapted to dispense chemical onto the polishing surface during the polishing operation; and

a drive mechanism adapted to move the polishing head relative to the polishing surface during the polishing operation.

15. (Currently Amended) A method of polishing a substrate having a surface using a polishing apparatus comprising a polishing surface, a carrier having a subcarrier and a retaining ring circumferentially disposed about the subcarrier, the retaining ring having a lower surface with an annular recess formed therein, the method comprising steps of:

positioning the substrate on the subcarrier;

pressing the surface of the substrate and the lower surface of the retaining ring against the polishing surface, deforming the polishing surface under the retaining ring;

providing relative motion between the carrier and the polishing surface to polish the surface of the substrate; and

enabling the polishing pad surface deformed under the retaining ring to partially rebound within the annular recess, the at least one recess positioned a predetermined distance from the inner edge of the retaining ring, the predetermined distance selected to reduce the area near the edge of the substrate having a lower polishing rate than a center of the substrate due to rebounding of the polishing surface, the predetermined distance selected based on magnitude of a force applied to the retaining ring during a polishing operation, magnitude of a force applied to the subcarrier during the polishing operation, or both.

16. (Original) A method according claim 15, wherein the polishing surface comprises a pad of pliant material capable of being deformed by the retaining ring during the polishing operation, and wherein the step of pressing the lower surface of the retaining ring against the polishing surface comprises the step of reducing an area near an edge of the substrate having a lower polishing rate than a center of the substrate due to rebounding of the pad from a deformed condition in a first region near the inner edge of the retaining ring.

17. A substrate having a surface polished according to the method of claim 15.

18. (Currently Amended) A polishing head according to claim 1, ~~for positioning a substrate having a surface on a polishing surface of a polishing apparatus, the polishing head comprising:~~

~~a carrier;~~

~~a subcarrier carried by the carrier and adapted to hold the substrate during a polishing operation;~~

and

~~a retaining ring disposed about the subcarrier and having a lower surface in contact with the polishing surface during the polishing operation, wherein the retaining ring comprises a polymer to inhibit spalling of the lower surface during the polishing operation.~~

19. A polishing head according to claim 18, wherein the polymer is selected to provide an operating life for the retaining ring adequate for processing at least about 2,000 substrates.

20. A polishing head according to claim 18, wherein the retaining ring is made entirely or in part of a polymer selected from a group consisting of:

polyesters;
polyethylene terephthalate;
polyimide;
polyphenylene sulfide;
polyetherketone; and
polybenzimidazole.

21. (Cancelled)

22. (Cancelled)

23. (Cancelled)

24. (Cancelled)

25. (New) A polishing head according to claim 9, wherein the at least one annular recess comprises a plurality of concentric grooves.

26. (New) A polishing head according to claim 11, wherein the at least one annular recess comprises a plurality of concentric grooves.

27. (New) A Chemical Mechanical Polishing (CMP) apparatus having a polishing head according to claim 9, the CMP apparatus further comprising:

a chemical dispensing mechanism adapted to dispense chemical onto the polishing surface during the polishing operation; and

a drive mechanism adapted to move the polishing head relative to the polishing surface during the polishing operation.

28. (New) A Chemical Mechanical Polishing (CMP) apparatus having a polishing head according to claim 11, the CMP apparatus further comprising:

a chemical dispensing mechanism adapted to dispense chemical onto the polishing surface during the polishing operation; and

a drive mechanism adapted to move the polishing head relative to the polishing surface during the polishing operation.

29. (New) A method according to claim 15, wherein the recess comprises an annular recess.

30. (New) A method of polishing a substrate having a surface using a polishing apparatus comprising a polishing pad surface, a carrier having a subcarrier and a retaining ring circumferentially disposed about the subcarrier, the retaining ring having a lower surface with an annular recess formed therein, the method comprising:

positioning the substrate on the subcarrier;

pressing the surface of the substrate and the lower surface of the retaining ring against the polishing pad surface, deforming the polishing surface under the retaining ring;

providing relative motion between the carrier and the polishing pad surface to polish the surface of the substrate; and

enabling the polishing pad surface deformed under the retaining ring to partially rebound within the annular recess, the annular recess having a predetermined depth and a predetermined radial width, the predetermined depth and the predetermined radial width selected based on magnitude of a force applied to the retaining ring during a polishing operation, magnitude of a force applied to the subcarrier during the polishing operation, or both.

31. (New) A substrate having a surface polished according to the method of claim 30.

32. (New) A method of polishing a substrate having a surface using a polishing apparatus comprising a polishing surface, a carrier having a subcarrier and a retaining ring circumferentially disposed about the subcarrier, the retaining ring having a lower surface with an annular recess formed therein, the method comprising:

positioning the substrate on the subcarrier;

pressing the surface of the substrate and the lower surface of the retaining ring against the polishing surface, deforming the polishing surface under the retaining ring;

providing relative motion between the carrier and the polishing surface to polish the surface of the substrate; and

enabling the polishing surface deformed under the retaining ring to partially rebound within the annular recess, wherein the annular recess comprises a groove having a curved cross-sectional area in a plane perpendicular to the lower surface of the retaining ring.

33. (New) A substrate having a surface polished according to the method of claim 32.
34. (New) A polishing head for positioning a surface of a substrate against a polishing surface, the polishing head comprising:
- a carrier;
 - a subcarrier carried by the carrier and adapted to hold the substrate during a polishing operation;
- and
- a retaining ring having an inner edge disposed about the subcarrier and a lower surface in contact with a polishing surface during the polishing operation, the lower surface of the retaining ring having a plurality of individual recesses distributed across the lower surface of the retaining ring.
35. (New) A polishing head according to claim 34, wherein at least one of the individual recesses comprises a hemispherical recess.
36. (New) A polishing head according to claim 34, wherein at least one of the individual recesses comprises a dimple.
37. (New) A polishing head according to claim 34, wherein said retaining ring comprises a polymer.
38. (New) A polishing head according to claim 34, wherein said polishing surface comprises a polishing pad.
39. (New) A polishing head according to claim 34, wherein said polishing of said substrate results in a planarization of said surface of said substrate.
40. (New) A polishing head according to claim 34, wherein said substrate comprises a semiconductor wafer substrate.
41. (New) A semiconductor wafer having a surface polished according to the method of claim 32.
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